CONSEIL PERMANENT INTERNATIONAL POUR
L'EXPLORATION DE LA MER
34 B. STRANDVEJ, HELLERUP — DANEMARK

# RAPPORTS
ET
# PROCÈS-VERBAUX DES RÉUNIONS

VOLUME C

3ÈME PARTIE

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(1935—1936)

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# 1.

## Continuous Current Measuring in the Southern Bight.

By

J. N. Carruthers, Fisheries Laboratory, Lowestoft.

This short paper has a very definite object — to support the plea that programmes of non-stop urrent measuring should be undertaken from as many ghtvessels as possible in the southern North Sea.

Such work seems essential if ever a proper study of ie connection between currents and certain fish uctuations is to become possible.

It is now quite easy and far from expensive to itiate and maintain all-weather observations from eel lightvessels at depths little below the surface. It possible to obtain all the information which seems ally necessary for the study in question, without any sk of getting behindhand with the working-up of ie records as they come in.

A new instrument has recently been in use from ie Smith's Knoll, Galloper and Sandettié light-essels on behalf of the Lowestoft laboratory[1]).

Below, sample records from these lightships are resented.

The instrument used has been described in the ugust 1935 issue of the Council's Journal and also the November issue of the Monaco Hydrographic eview.

The observations set out below can all be taken as lating to the nominal depth of $1^1/_2$ fathoms, and it to be noted that one can confidently hope that no me at all will be lost for long periods — since the strument remains working in all weathers.

The presentation of the records by themselves ould serve the writer's immediate purpose as stated ove; consequently only a few comments on the vo tables are made.

Attention is drawn to the magnitudes of the urrents; these are a matter for surprise and seem to nd some support to Tait's opinion that hitherto ur ent speeds have been considerably underestimated om drift-bottle work. To decide this point, atten-on will have to be devoted not to daily values, it to those relating to periods of a month and ore.

The variation of current direction with wind direc-on is noteworthy and deserves detailed study. articularly noteworthy is the range in total water-ovements, and it is not hard to imagine that this ay be of importance to fishery problems. The riation of total water-movements with the phase d distance of the moon is interesting.

In connection with the Sandettié results, reference should be made to Heldt's work on log-ship observations from that lightvessel — an account of which is given in the present writer's first Varne paper. It may be mentioned too, that since a counter costs only 4/6d, such a mishap as occurred at the Sandettié on 3rd January (and which may be expected to be very rare) involves no expense to matter.

It need hardly be added that the Sandettié results set out below, provide interesting material for comparison with the routine drift-indicator observations on the Varne lightvessel. The relevant results from the latter are not given here but it is of interest to state that the representative daily flow past the Varne during December 1935, was:—

6.4 miles towards N. 24° E.

### Further Data.

Since the foregoing was written, results from the Galloper lightvessel have become available. They are set down in the table which follows. It is of great interest to notice how very different in direction the residual currents at the Galloper were on some occasions from those at the Sandettié at the same times. In this connection the periods 1—3 December and 6—10 January may be referred to. Attention may be drawn to the fact that the residual current at the Galloper can be against the wind; examples of this are to be seen in the table with winds from three different quadrants.

When it is remembered that the Galloper and Sandettié lightvessels are only thirty-one miles apart (the former bearing N. 6° E. true from the latter) it is clear that very much more observing needs to be done before we can hope to learn the nature of the circulation of the southern North Sea at all satisfactorily.

Positions of Lightships.

| | |
|---|---|
| Smith's Knoll ..... | 52°43′ N. — 2°17′ E. |
| Galloper ..... | 51°44′ N. — 1°58′ E. |
| Sandettié ..... | 51°13′ N. — 1°54′ E. |

[1]) That it was possible to carry out the observations aboard the Sandettié lightship was due to the kind collaboration of the Office Scientifique et Technique des Pêches Maritimes, and thanks are here expressed to Messieurs le Gall and Furnestin for much helpful assistance.

## Smith's Knoll Lightvessel.

| Ref. No. of Record | Lunar Day Centred on:— | Sea-Miles of Water-Movement towards the Octant Centred on:— | | | | | | | | Sea-Miles of Water-Movement towards all directions; totals of entries in preceding eight Columns[1]) | | Residual Current[2]) | | Residual Wind[3]) | | Mean Wind Strength[4]) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | N | NE | E | SE | S | SW | W | NW | | | | | | | |
| 27 | 1915 on 11. 11. 35 | 22.22 | 0.54 | 0.40 | 1.34 | 20.49 | 0.04 | Nil | 0.03 | 45.07 | | 2.0 | N. 45° E. | 15.6 | S. 10° W. | 16.1 |
| 28 | 2005 - 12. 11. 35 | 18.29 | 1.35 | 1.48 | 9.61 | 9.25 | Nil | Nil | Nil | 39.98 | | 9.8 | N. 60° E. | 18.6 | S. 21° W. | 19.7 |
| 29 | 2055 - 13. 11. 35 | 15.57 | 1.39 | 1.19 | 1.65 | 18.96 | 0.14 | 0.14 | 0.10 | 39.14 | | 4.7 | S. 51° E. | 18.0 | S. 39° W. | 19.0 |
| 30 | 2145 - 14. 11. 35 | 9.54 | 10.60 | 0.35 | 2.86 | 10.00 | 0.30 | Nil | Nil | 33.66 | | 10.8 | N. 52° E. | 22.9 | S. 2° W. | 23.7 |
| 31 | 2235 - 15. 11. 35 | 16.07 | 0.54 | 0.27 | 1.30 | 15.16 | 0.15 | 0.14 | 0.19 | 33.81 | | 1.3 | N. 61° E. | 14.2 | S. 5° W. | 14.9 |
| 32 | 2325 - 16. 11. 35 | 13.20 | 0.14 | 0.11 | 0.93 | 14.66 | 0.61 | 0.18 | 0.07 | 29.88 | | 2.4 | S. 16° E. | 14.1 | S. 39° E. | 17.6 |
| 33 | 0015 - 18. 11. 35 | 10.77 | 1.23 | 0.99 | 0.83 | 7.54 | 0.23 | 0.01 | 0.14 | 21.73 | L.Q. | 4.1 | N. 21° E. | 14.7 | Due S. | 17.7 |
| 34 | 0105 - 19. 11. 35 | 10.40 | 0.57 | 0.56 | 0.88 | 10.31 | Nil | Nil | 0.04 | 22.76 | | 1.5 | N. 83° E. | 9.6 | S. 54° W. | 10.0 |
| 35 | 0155 - 20. 11. 35 | 13.89 | 0.27 | 0.15 | 0.26 | 7.77 | 0.30 | 0.27 | 0.49 | 23.38 | A. | 6.3 | N. 14° W. | 13.5 | S. 42° E. | 15.9 |
| 36 | 0245 - 21. 11. 35 | 4.20 | 0.21 | 0.11 | 0.14 | 9.54 | 0.52 | 0.66 | 0.59 | 15.99 | | 5.4 | S. 1° E. | 14.4 | S. 69° E. | 15.0 |
| 37 | 0335 - 22. 11. 35 | 11.81 | Nil | 0.02 | Nil | 12.07 | 0.73 | 0.73 | 0.68 | 26.03 | | 1.7 | S. 69° W. | 11.7 | N. 79° E. | 11.7 |
| 38 | 0425 - 23. 11. 35 | 9.20 | 0.20 | 0.15 | 0.45 | 17.05 | 0.73 | 0.82 | 0.74 | 29.32 | | 8.1 | S. 2° E. | 13.5 | N. 43° E. | 13.9 |
| 39 | 0515 - 24. 11. 35 | 9.49 | 0.63 | 0.51 | 0.70 | 20.06 | 0.41 | 0.33 | 0.47 | 32.60 | | 10.6 | S. 14° E. | 11.8 | N. 3° W. | 13.0 |
| 40 | 0605 - 25. 11. 35 | 12.24 | 0.75 | 1.10 | 0.92 | 20.40 | 0.16 | 0.10 | 0.16 | 35.82 | | 8.5 | S. 24° E. | 8.3 | N. 69° W. | 10.0 |
| 41 | 0655 - 26. 11. 35 | 14.14 | 0.36 | 0.21 | 0.47 | 19.39 | 0.31 | 0.39 | 0.40 | 35.78 | N.M. | 5.3 | S. 10° E. | 14.2 | S. 42° W. | 14.8 |
| 42 | 0745 - 27. 11. 35 | 14.60 | 0.60 | 0.34 | 0.77 | 20.22 | 0.39 | 0.29 | 0.31 | 37.52 | | 5.8 | S. 16° E. | 15.8 | S. 75° W. | 16.2 |
| 43 | 0835 - 28. 11. 35 | 17.59 | 0.47 | 0.33 | 0.33 | 18.67 | 0.29 | 0.23 | 0.30 | 38.20 | | 1.2 | S. 23° E. | 16.8 | S. 48° W. | 19.0 |
| 44 | 0925 - 29. 11. 35 | 15.01 | 0.76 | 1.20 | 1.00 | 19.89 | 0.14 | 0.03 | 0.38 | 38.40 | | 5.3 | S. 34° E. | 18.8 | S. 75° W. | 19.0 |
| 45 | 1015 - 30. 11. 35 | 17.98 | 0.55 | 0.44 | 0.61 | 15.13 | 0.18 | 0.11 | 0.15 | 35.16 | | 2.9 | N. 7° E. | 21.5 | S. 53° W. | 22.3 |
| 46 | 1105 - 1. 12. 35 | 14.41 | 0.24 | 0.49 | 0.32 | 16.79 | 0.34 | 0.18 | 0.22 | 32.99 | | 2.5 | S. 18° E. | 29.0 | S. 73° W. | 30.7 |
| 47 | 1155 - 2. 12. 35 | 12.40 | 0.34 | 0.44 | 0.43 | 17.93 | 0.29 | 0.23 | 0.24 | 32.31 | | 5.6 | S. 15° E. | 30.2 | S. 88° W. | 30.8 |
| 48 | 1245 - 3. 12. 35 | 13.57 | 0.39 | 0.33 | 0.25 | 14.93 | 0.38 | 0.13 | 0.28 | 30.25 | F.Q. | 1.3 | S. 19° E. | 20.5 | S. 79° W. | 21.0 |
| 49 | 1335 - 4. 12. 35 | 11.12 | 0.70 | 0.48 | 0.66 | 16.94 | 0.27 | 0.10 | 0.11 | 30.37 | | 6.0 | S. 22° E. | 12.6 | N. 80° W. | 13.5 |
| 27 to 49 = 23 Lunar Days Centred on:— 0425 on 23. 11. 35 | | 13.38 | 0.99 | 0.51 | 1.16 | 15.35 | 0.30 | 0.22 | 0.26 | 32.18 | | 2.6 | S. 45° E.[5]) | 9.4 | S. 44° W. | 17.6 |

Notes concerning the above Smith's Knoll Table.

[1]) The letters on the right in this column show when the Moon was Full (F.M.), New (N.M.), in the First Quarter (F.Q.), in the Last Quarter (L.Q.), in Perigee (P.), and in Apogee (A.). It may be noted that the Moon had been Full on 10th November and in Perigee on 8th November.

[2]) Sea-miles per lunar day towards true directions. The entries in this column are simple resultants derived from the data in columns 3—10 concerning which, it is to be noted, that all water movements within the various octants have been arbitrarily referred to the middle directions.

[3]) Miles per hour from true directions. Estimates of wind strength and direction were made every three hours aboard the lightvessel according to the Beaufort Scale. After conversion to m. p. h. appropriate vector-averages were struck for each day.

[4]) Simply arithmetical averages of the actual wind strengths observed.

[5]) This direction is towards Schouwen.

## Sandettié Lightvessel.

| Record | Lunar Day Centred on:— | Sea-Miles of Water-Movement towards the Octant Centred on:— N | NE | E | SE | S | SW | W | NW | Sea-Miles of Water-Movement towards all directions; totals of entries in preceding eight columns[3]) | | Residual Current[4]) | | Wind[5]) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1925 on 1. 12. 35 | Nil | 12.95 | Nil | 0.20 | 14.64 | 0.04 | Nil | Nil | 27.84 | | 10.8 | S. 69° E. | 4-W. |
| 2 | 2015 - 2. 12. 35 | Nil | 11.10 | Nil | 5.99 | 9.84 | Nil | Nil | Nil | 26.93 | | 13.6 | S. 73° E. | 4-W. |
| 3 | 2105 - 3. 12. 35 | Nil | 11.46 | Nil | Nil | 14.56 | Nil | Nil | Nil | 26.02 | F.Q. | 11.1 | S. 77° E. | 3-W. |
| 4 | 2155 - 4. 12. 35 | 0.10 | 9.50 | 0.07 | Nil | 14.36 | Nil | Nil | Nil | 24.03 | | 10.1 | S. 52° E. | |
| 5 | 2245 - 5. 12. 35 | Nil | 10.66 | Nil | Nil | 9.26 | 6.30 | Nil | Nil | 26.21 | P. | 6.9 | S. 36° E. | |
| 6 | 2335 - 6. 12. 35 | Nil | 13.35 | Nil | Nil | 12.31 | Nil | Nil | Nil | 25.66 | | 9.9 | S. 83° E. | |
| 7 | 0025 - 8. 12. 35 | Nil | 16.31 | Nil | Nil | 13.09 | Nil | Nil | Nil | 29.40 | | 11.6 | N. 88° E. | |
| 8 | 0115 - 9. 12. 35 | Nil | 14.52 | Nil | Nil | 9.91 | 7.60 | Nil | Nil | 32.03 | | 7.0 | S. 54° E. | |
| 9 | 0205 - 10. 12. 35 | Nil | 8.89 | Nil | Nil | 21.82 | Nil | Nil | Nil | 30.70 | F.M. | 16.8 | S. 32° E. | |
| 0 | 0255 - 11. 12. 35 | Nil | 10.24 | Nil | Nil | 23.09 | Nil | Nil | Nil | 33.33 | | 17.5 | S. 35° E. | |
| 1 | 0345 - 12. 12. 35 | Nil | 17.06 | Nil | Nil | 17.32 | Nil | Nil | Nil | 34.38 | | 13.1 | S. 77° E. | |
| | | See below — Note [1]) | | | | | | | | | | | | |
| 2 | 0110 - 14. 12. 35 | Nil | 19.69 | 0.12 | Nil | Nil | 11.51 | 0.27 | Nil | 31.59 | | 8.1 | N. 34° E. | |
| 3 | 0200 - 15. 12. 35 | 0.07 | 22.21 | Nil | Nil | Nil | 9.86 | Nil | Nil | 32.14 | | 12.5 | N. 35° E. | |
| 4 | 0250 - 16. 12. 35 | Nil | 19.35 | 0.36 | Nil | 1.07 | 6.73 | Nil | Nil | 27.51 | | 12.1 | N. 40° E. | |
| 5 | 0340 - 17. 12. 35 | Nil | 9.95 | 0.06 | 0.10 | 2.99 | 9.16 | Nil | Nil | 22.26 | L.Q. | 2.6 | S. 25° E. | |
| 6 | 0430 - 18. 12. 35 | Nil | 6.42 | Nil | 0.22 | 3.85 | 8.28 | Nil | Nil | 18.77 | A. | 5.5 | S. 2° W. | |
| 7 | 0520 - 19. 12. 35 | 0.41 | 7.47 | Nil | Nil | 5.06 | 1.16 | 0.68 | 0.17 | 14.95 | | 3.7 | N. 81° E. | |
| 8 | 0610 - 20. 12. 35 | Nil | 5.14 | 1.36 | Nil | 0.21 | 9.69 | Nil | Nil | 16.40 | | 3.9 | S. 19° W. | 2-NW. |
| 9 | 0700 - 21. 12. 35 | Nil | 7.07 | 0.56 | Nil | 4.82 | 5.69 | Nil | Nil | 18.14 | | 4.1 | S. 32° E. | |
| 0 | 0750 - 22. 12. 35 | Nil | 10.04 | Nil | Nil | Nil | 15.63 | Nil | Nil | 25.67 | | 5.6 | S. 35° W. | 2-NW. |
| 1 | 0840 - 23. 12. 35 | Nil | 10.24 | Nil | Nil | 0.06 | 14.99 | Nil | Nil | 25.28 | | 4.8 | S. 34° W. | |
| 2 | 0930 - 24. 12. 35 | 4.01 | 11.14 | 0.09 | Nil | Nil | 11.77 | Nil | Nil | 27.01 | | 3.6 | N. 19° W. | 2/3-SE. |
| 3 | 1020 - 25. 12. 35 | Nil | 21.17 | Nil | Nil | Nil | 10.55 | Nil | Nil | 31.72 | N.M. | 10.6 | N. 35° E. | |
| 4 | 1110 - 26. 12. 35 | Nil | 21.26 | Nil | Nil | 8.34 | 5.64 | Nil | Nil | 35.24 | | 11.4 | N. 66° E. | 5-SW. |
| 5 | 1200 - 27. 12. 35 | Nil | 22.13 | Nil | Nil | 10.77 | Nil | Nil | Nil | 32.89 | | 16.3 | N. 63° E. | |
| 6 | 1250 - 28. 12. 35 | Nil | 18.78 | Nil | Nil | 6.95 | 10.36 | Nil | Nil | 36.09 | | 6.0 | Due E. | |
| 7 | 1340 - 29. 12. 35 | Nil | 16.42 | Nil | Nil | Nil | 13.97 | Nil | Nil | 30.39 | | 2.5 | N. 35° E. | |
| 8 | 1430 - 30. 12. 35 | Nil | 21.95 | Nil | Nil | Nil | 11.10 | Nil | Nil | 33.06 | P. | 10.9 | N. 35° E. | |
| 9 | 1520 - 31. 12. 35 | Nil | 18.41 | Nil | Nil | Nil | 13.07 | Nil | Nil | 31.49 | | 5.3 | N. 35° E. | |
| 0 | 1610 - 1. 1. 36 | Nil | 16.60 | Nil | Nil | Nil | 10.10 | Nil | Nil | 26.71 | F.Q. | 6.5 | N. 35° E. | |
| 1 | 1700 - 2. 1. 36 | Nil | 13.63 | Nil | Nil | Nil | 11.72 | Nil | Nil | 25.35 | | 1.9 | N. 35° E. | |
| | | See below — Note [2]) | | | | | | | | | | | | 2/3-NW. |
| 2 | 1840 - 4. 1. 36 | 3.94 | 4.91 | Nil | Nil | Nil | 13.70 | Nil | Nil | 22.56 | | 6.6 | S. 60° W. | |
| 3 | 1930 - 5. 1. 36 | Nil | 17.03 | Nil | Nil | Nil | 5.86 | Nil | Nil | 22.89 | | 11.2 | N. 35° E. | |
| 4 | 2020 - 6. 1. 36 | Nil | 19.77 | Nil | Nil | Nil | 7.11 | Nil | Nil | 26.89 | | 12.7 | N. 35° E. | |
| 5 | 2110 - 7. 1. 36 | Nil | 20.23 | Nil | Nil | Nil | 10.97 | Nil | Nil | 31.20 | | 9.3 | N. 35° E. | 3/4-SW. |
| 6 | 2200 - 8. 1. 36 | Nil | 18.86 | Nil | Nil | Nil | 10.34 | Nil | Nil | 29.21 | F.M. | 8.5 | N. 35° E. | 3/4-SW. |
| 7 | 2250 - 9. 1. 36 | Nil | 22.17 | Nil | Nil | Nil | 6.53 | Nil | Nil | 28.70 | | 15.6 | N. 35° E. | |
| 8 | 2340 - 10. 1. 36 | Nil | 19.39 | Nil | Nil | 6.13 | 9.45 | Nil | Nil | 34.97 | | 7.1 | N. 73° E. | |
| 8 | Lunar Days centred n:— 1925 on 31. 12. 35 | 0.22 | 14.67 | 0.07 | 0.17 | 5.54 | 7.08 | 0.03 | 0.00 | 27.78 | | 5.5 | N. 81° E.[6]) | |

Notes concerning the above Sandettié Table.

[1]) This break occurred through the Crew unrigging the Instrument for the Relief.

[2]) Here, one of the Counters stopped working and was not replaced soon enough for the Record to be acceptable.

[3]) and [4]) The remarks made in the case of the Smiths Knoll lightvessel apply here also.

[5]) Entries in this column convey some idea as to what wind conditions were associated with various directions of water-flow. The figures re Beaufort numbers.

[6]) This direction is towards Flushing.

## Galloper Lightvessel.

| Ref. No. of Record | Lunar Day Centred on:— | Sea-Miles of Water-Movement towards the Octant Centred on:— N | NE | E | SE | S | SW | W | NW | Sea-Miles of Water Movement towards all directions; totals of entries in preceding eight columns[2]) | | Residual Current[2]) | | Wind[2]) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2145 on 1. 12. 35 | 7.60 | 2.97 | — | — | — | 4.42 | 7.94 | 2.69 | 25.63 | | 13.8 | N. 62° W. | 6/7 — WNW |
| 2 | 2235 - 2. 12. 35 | 3.82 | 6.55 | — | — | — | 6.40 | 2.32 | 5.38 | 24.47 | | 9.8 | N. 48° W. | ,, |
| 3 | 2325 - 3. 12. 35 | 2.20 | 8.93 | — | — | — | 11.11 | 0.60 | 0.65 | 23.49 | F.Q. | 2.8 | N. 77° W. | 5 — WNW |
| 4 | 0015 - 5. 12. 35 | 1.16 | 10.91 | 0.08 | — | 0.64 | 9.31 | 0.11 | 0.84 | 23.06 | P. | 2.3 | N. 3° E. | 4 — NW to W |
| 5 | 0105 - 6. 12. 35 | 1.06 | 11.78 | — | — | 0.02 | 10.62 | 1.35 | — | 24.83 | | 1.9 | N. 26° W. | |
| 6 | 0155 - 7. 12. 35 | 2.94 | 9.59 | — | — | 0.15 | 11.76 | 0.55 | — | 25.00 | | 2.4 | N. 69° W. | |
| 7 | 0245 - 8. 12. 35 | 0.26 | 12.77 | 0.62 | — | — | 14.68 | — | — | 28.33 | | 1.3 | S. 24° W. | |
| 8 | 0335 - 9. 12. 35 | 0.40 | 14.37 | 0.71 | — | — | 13.44 | 1.13 | — | 30.04 | | 1.1 | N. 3° E. | |
| 9 | 0425 - 10. 12. 35 | 0.18 | 20.56 | — | — | — | 8.46 | — | — | 29.20 | F.M. | 12.2 | N. 34° E. | 5/8 — NNE |
| 10 | 0515 - 11. 12. 35 | — | 20.42 | — | — | — | 11.34 | 0.26 | — | 32.02 | | 8.9 | N. 34° E. | |
| 11 | 0605 - 12. 12. 35 | 0.11 | 15.80 | 0.55 | — | 0.13 | 16.00 | 0.32 | — | 32.91 | | 0.3 | S. 29° E. | 4/5 — ENE |
| 12 | 0655 - 13. 12. 35 | 8.76 | 6.03 | 0.81 | — | 0.77 | 14.90 | — | — | 31.28 | | 5.7 | N. 82° W. | |
| 13 | 0745 - 14. 12. 35 | — | 15.18 | 0.34 | — | — | 14.87 | 0.30 | — | 30.69 | | 0.3 | N. 40° E. | |
| 14 | 0835 - 15. 12. 35 | — | 11.44 | — | 0.03 | — | 15.12 | 1.00 | — | 27.60 | | 4.4 | S. 44° W. | 3/5 — SSW |
| 15 | 0925 - 16. 12. 35 | — | 7.02 | — | — | 0.45 | 9.55 | 1.03 | 0.53 | 18.59 | | 3.7 | S. 50° W. | |
| 16 | 1015 - 17. 12. 35 | 0.20 | 11.20 | — | — | — | 6.23 | 3.00 | 0.05 | 20.68 | L.Q. | 3.8 | N. 3° W. | |
| 17 | 1105 - 18. 12. 35 | 0.32 | 6.18 | — | — | — | 9.03 | 0.43 | — | 15.96 | A. | 3.0 | S. 45° W. | |
| 18 | 1155 - 19. 12. 35 | — | 8.17 | 5.13 | — | — | 3.61 | — | 0.14 | 17.05 | | 8.9 | N. 58° E. | |
| 19 | 1245 - 20. 12. 35 | — | 4.33 | 5.26 | — | — | 1.10 | 7.08 | — | 17.76 | | 2.3 | N. 1° E. | |
| 20 | 1335 - 21. 12. 35 | 4.89 | 5.96 | — | — | — | 7.76 | 0.31 | — | 18.91 | | 4.0 | N. 34° W. | 3 — NW to NNW |
| 21 | 1425 - 22. 12. 35 | 3.07 | 5.07 | — | — | — | 8.22 | 4.65 | — | 21.01 | | 6.9 | S. 87° W. | |
| 22 | 1515 - 23. 12. 35 | 6.00 | 8.53 | — | — | — | 7.09 | — | — | 21.63 | | 7.1 | N. 2° W. | |
| | | | | | | See Below — Note [1]) | | | | | N.M. | | | |
| 23 | 1745 - 26. 12. 35 | — | 9.13 | — | — | — | 32.39 | — | — | 41.52 | | 23.2 | S. 35° W. | 4/7 — SSW |
| 24 | 1835 - 27. 12. 35 | — | 13.64 | — | — | — | 20.33 | — | — | 33.97 | | 6.7 | S. 35° W. | 3/7 — S |
| 25 | 1925 - 28. 12. 35 | — | 16.80 | — | — | — | 15.23 | — | — | 32.03 | | 1.6 | N. 35° E. | |
| 26 | 2015 - 29. 12. 35 | 0.15 | 13.38 | — | — | — | 19.74 | — | — | 33.27 | | 6.3 | S. 36° W. | |
| 27 | 2105 - 30. 12. 35 | 0.81 | 8.00 | 0.74 | — | — | 19.87 | — | — | 29.42 | P. | 10.8 | S. 35° W. | 6/8 — S to SW |
| 28 | 2155 - 31. 12. 35 | — | 14.19 | — | — | — | 17.13 | — | — | 31.32 | | 2.9 | S. 35° W. | |
| 29 | 2245 - 1. 1. 36 | — | 11.51 | — | — | — | 16.39 | — | — | 27.90 | F.Q. | 4.9 | S. 35° W. | |
| 30 | 2335 - 2. 1. 36 | — | 7.27 | — | — | — | 12.07 | — | — | 19.34 | | 4.8 | S. 35° W. | |
| 31 | 0025 - 4. 1. 36 | — | 16.02 | — | — | — | 11.02 | — | — | 27.04 | | 5.0 | N. 35° E. | |
| 32 | 0115 - 5. 1. 36 | — | 12.60 | — | — | — | 10.59 | — | — | 23.19 | | 2.0 | N. 35° E. | |
| 33 | 0205 - 6. 1. 36 | — | 9.77 | — | — | — | 16.60 | — | — | 26.37 | | 6.8 | S. 35° W. | 6/8 — S |
| 34 | 0255 - 7. 1. 36 | — | 9.23 | — | — | — | 18.13 | — | — | 27.36 | | 8.9 | S. 35° W. | |
| 35 | 0345 - 8. 1. 36 | — | 12.81 | — | — | — | 17.39 | — | — | 30.20 | F.M. | 4.6 | S. 35° W. | |
| 36 | 0345 - 9. 1. 36 | — | 11.09 | — | — | — | 19.56 | — | — | 30.65 | | 8.5 | S. 35° W. | |
| 37 | 0525 - 10. 1. 36 | — | 10.17 | — | — | — | 18.41 | — | — | 28.57 | | 8.2 | S. 35° W. | |
| 38 | 0615 - 11. 1. 36 | — | 16.76 | — | — | — | 14.42 | — | — | 31.19 | | 2.3 | N. 35° E. | |
| 39 | 0705 - 12. 1. 36 | — | 19.61 | — | — | — | 11.57 | — | — | 31.19 | | 8.0 | N. 35° E. | 2/3 — NW |
| 40 | 0755 - 13. 1. 36 | — | 14.94 | — | — | — | 13.15 | — | — | 28.09 | | 1.8 | N. 35° E. | |
| 41 | 0845 - 14. 1. 36 | — | 16.76 | — | — | — | 10.33 | — | — | 27.09 | | 6.4 | N. 35° E. | 3/4 — NW to NNW |
| 42 | 0935 - 15. 1. 36 | — | 12.87 | — | — | — | 12.00 | — | — | 24.87 | | 0.9 | N. 35° E. | |
| 42 | Lunar Days Centred on:— 1515 on 23. 12. 35 | 1.05 | 11.44 | 0.34 | 0.00 | 0.05 | 12.89 | 0.77 | 0.24 | 26.78 | | 1.6 | S. 85° W.[3]) | |

Notes Concerning the above Galloper Table.

[1]) This break was caused by a defective counter.
[2]) The remarks made below the other two tables apply here also.
[3]) This direction is towards Burnham on Crouch.

# 2.

## The Importance of certain Plankton Animals as Indicators of Water Movements in the Western End of the English Channel.

By

F. S. Russell,

Naturalist at the Plymouth Laboratory of the Marine Biological Association.

The use of plankton animals as indicators of water masses has been one of the aims of plankton esearch for many years. Recently some of the animals hich can be used to show the distribution of water asses at the western end of the English Channel ave been determined.

A study of the Sagitta population off Plymouth ows that two species, *S. elegans* and *S. setosa*, may e found. At times these species occur together, while t times either one or the other species alone is resent. It has now been established that these differnces observed off Plymouth are because the two ecies of Sagitta are characteristic of two distinct ater masses.

The periodic changes in the Sagitta population from ie year 1930 to the beginning of 1935 are shown in igure 1. The full details regarding this work have een published (Russell, 1935, b). The diagrams ow clearly that the year 1930 was characterised by ie predominance of *S. elegans*, and that this species ntinued to make up a large percentage of the tches until September, 1931, when *S. setosa* started predominate. This dominance of *S. setosa* has ntinued up to the end of 1935, except for occasional nall incursions of *S. elegans*. From examination of aterial from the south of Ireland and off the mouth the Channel, kindly supplied by Mr. G. P. Farran nd Dr. J. Le Gall, it was evident that *S. elegans* as characteristic off the mouth of the Channel and at the presence of this species off Plymouth in 1930 d 1931 was due to a large extension of this water o the Channel. This received further support from mparison with data obtained by Dr. J. N. Carthers on the drift of water through the Straits of over. It was shown (Carruthers, 1934) that during 30 and until August, 1931, the direction of flow d a strong easterly component. This condition then oke down synchronously with the predominance of *setosa* off Plymouth, which species has continued predominate.

The occurrence or absence of *S. elegans* off Plymouth showed also an agreement with the occurrence or absence of dense patches of phytoplankton in the southern North Sea (Savage and Hardy, 1935). When *S. elegans* predominated off Plymouth the diatom patches were slight, but the presence of *S. setosa* off Plymouth coincided with heavy diatom outbursts in the southern North Sea.

The above information suggested that the changes in the Sagitta population off Plymouth were dependent on the strength of flow of Atlantic water into the North Sea from the north, *S. elegans* occurring off Plymouth when that flow was slight (Fig. 2). This agrees with Carruthers' theory that "the Dover Straits current waxes and wanes through the year in a sort of buffer relationship with the current from the north" (Carruthers, 1934).

An examination of the plankton catches taken since 1930 at Plymouth showed that a number of other species were found to be associated with *S. elegans*, and that at times there were other animals which are probably characteristic of Atlantic water coming from the south west past Ushant or of a more southerly distribution than that in which *S. elegans* normally lives. It remained to prove that the distribution of the water masses at the Channel mouth could be clearly shown by an examination of plankton catches. In July, 1935, through the kindness of Col. E. T. Peel a cruise was made in his yacht "St. George" off the mouth of the Channel. The full results of this cruise have been published (Russell, 1936, a). The general distribution of the water masses as inferred from the plankton is shown in Figure 3. The water in which *S. elegans* and its associated fauna lived was distinctly marked off from Channel water, and a tongue of water extending up past Ushant was also indicated by a different plankton content. The differences in the plankton composition of the three types of water were immediately evident as soon as the catches came on board. As a result it is safe to assume that a study

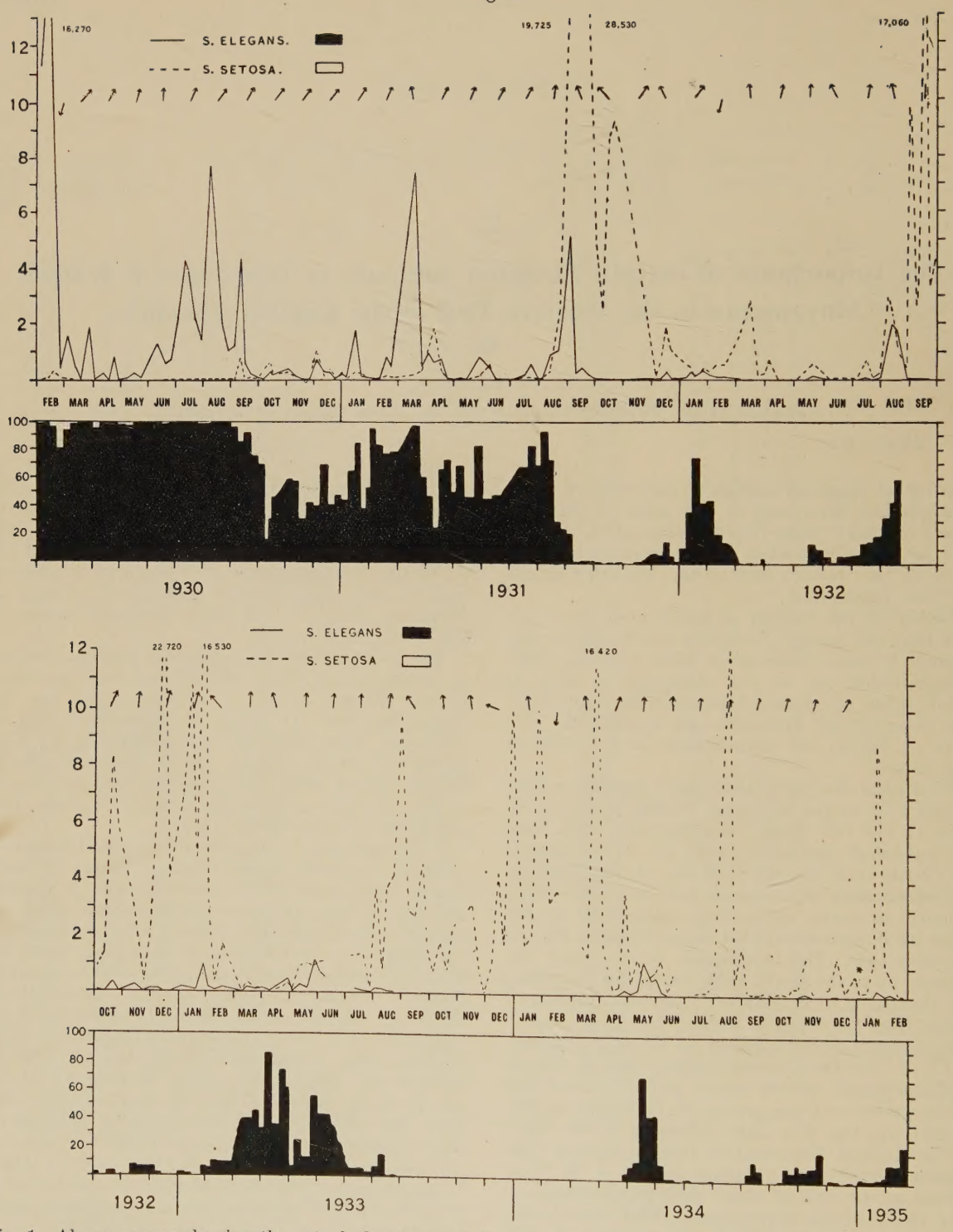


Fig. 1. Above, curves showing the actual abundance of *S. elegans* ( ——— ) and *S. setosa* ( - - - - - ) in half-hour oblique hauls with the 2-metre ring-trawl made usually at weekly intervals during the period February, 1930, to February, 1935. (The numbers are in thousands).
Below, the percentage composition of the Sagitta populations during the same period; *S. elegans*, black; *S. setosa*, white. At the top of the diagrams the arrows indicate the mean direction (true) of flow of water through the Straits of Dover for each month as indicated by the Carruthers' Current Meter working from the Varne Lightship. (After Russell, 1935, b, Figs. 1 & 2).

g. 2. Chart showing the hypothetical centre of distri-ution of *Sagitta setosa* in the North Sea and English hannel (unbroken line boundaries) and the change in stribution effected by an increase of flow of water from e north into the North Sea (broken line boundaries). (After Russell, 1935, b, Fig. 6).

the distribution of certain plankton animals will rove a valuable practical aid in hydrographical work n the water movements at the western end of the hannel.

The salinity changes in the mouth of the Channel ave been shown by Harvey (1934) to agree generally ith the conditions of flow through the Dover Straits. this respect it is possible that eventually the ankton indicators may be found to be associated ith certain isohalines, but they have the added value at they add definition to the picture by showing clearly the different bodies of water.

The indicators of use for this purpose are given low:

Atlantic "*elegans*" water. The medusa *Aglantha ser* and *Cosmetira pilosella* (in summer only), the onophore *Stephanomia bijuga*, *Sagitta elegans* and *agitta serratodentata* (in years of strong flow into the hannel), the amphipod *Themisto gracilipes*, the eropod Clione, and Euphausian adults and larvae hen occurring in large numbers). This plankton ppears to be very rich in quantity and is of a high t content.

Channel water. Probably the only true indicator *Sagitta setosa* when present. The water is also characterised by an absence of the *elegans* indicators, and by a poor plankton content.

?Water south of "*elegans*" water. The medusa Liriope, the Siphonophore Muggiaea, ?Noctiluca, Salps and Doliolids. The indicators of this water need to be worked out in more detail.

The distribution of the water masses as shown by the plankton in July, 1935, (Figure 3) agrees well with what might be expected at certain times from our knowledge of the hydrography of this region. There is a high probability that the *elegans* water is that which is known to be in cyclonic circulation off the south of Ireland (Matthews, 1914; Lumby, 1925; and Harvey, 1930). A more detailed examination of the size of the Sagitta has also shown their value in indicating the movements of water in the Scillies—Land's End region, as it appears that young *S. elegans* may drift off in the surface layers from *elegans* water (Russell, 1936, a).

The changes in the Sagitta population off Plymouth have further shown remarkable agreement with fluctuations in the winter maxima of phosphate present in the water. The years in which *S. setosa*, indicating Channel water, predominate have been characterised by low winter phosphate values, and it appears probable that the *S. elegans* water, enriched by upwelling along the Atlantic slope, may have important effects when it enters the Channel. Agreement has at any rate been shown between the phosphate values and the abundance of young fish off Plymouth (Russell, 1935, a, and 1936, b), and there is the possibility that movements of herring and other fish may be linked with these water changes in the future.

The parallel between the winter maximum of phosphate and the number of young fish in the following year is worth emphasizing. The actual figures are given below (from Russell, 1936, b). The table shows the percentage deviation of the winter maximum each year from the mean phosphate content at E1 for the winters 1923—24 to 1934—35, and the numbers of the young of summer-spawning fish caught in half-hour oblique hauls with the 2-metre stramin ring-trawl expressed as the sums of the monthly average catches. The phosphate values have been determined by Dr. W. R. G. Atkins and Dr. L. H. N. Cooper.

| Winter | Phosphate % deviation from mean | Year | Young fish |
|---|---|---|---|
| 1923—24 | +20 | 1924 | 696 |
| 1924—25 | + 2 | 1925 | 140 |
| 1925—26 | +29 | 1926 | 909 |
| 1926—27 | — 3 | 1927 | 170 |
| 1927—28 | +17 | 1928 | (no records) |
| 1928—29 | +17 | 1929 | 321 |
| 1929—30 | (no records) | 1930 | 403 |
| 1930—31 | — 6 | 1931 | 230 |
| 1931—32 | —21 | 1932 | 197 |
| 1932—33 | — 9 | 1933 | 117 |
| 1933—34 | —18 | 1934 | 79 |
| 1934—35 | —26 | 1935 | 37 |

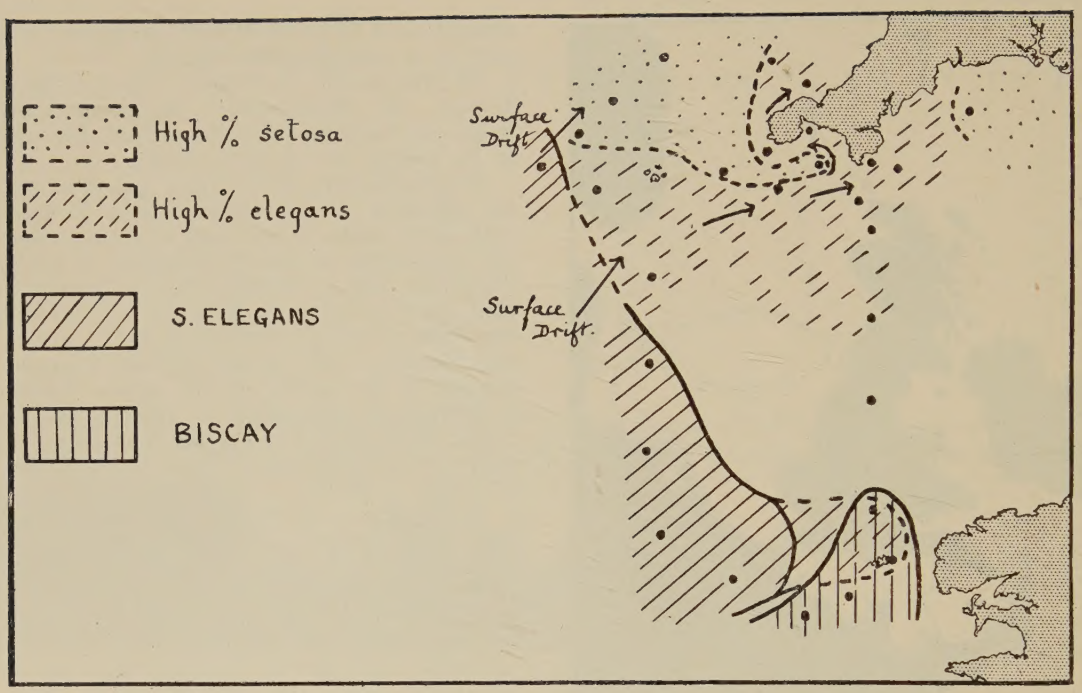


Fig. 3. Distribution of water masses in English Channel mouth region as inferred from collections of plankton made on Col. PEEL's yacht "St. George", July 1935. (After RUSSELL, 1936, a, Fig. 6). The area shown by dots or dashes is that in which a mixture of small individuals of *S. elegans* with *S. setosa* was found.

The only anomaly in this series of observations is the year 1932, when the young fish figure might have been expected to have been lower.

The winter 1929—30 when there were no phosphate records was marked by the presence of *S. elegans* water off Plymouth; if the premises be correct there should therefore have been a high phosphate content which would be in agreement with the large number of young fish in 1930.

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# 3.

## Length, Age Distribution and Growth of Herring in the Flemish Bight, 1935—36.

By

J. J. Tesch, 's Gravenhage.

From the beginning of October 1935 till the end of February 1936 we carried on our usual investigations on the herring during the East-Anglia fishery and afterwards. Every week (except in the second half of December) we obtained samples of fresh herrings (of about 200 ind.) caught by drift-nets. The samples came mostly from Smith Knoll, also from Haisborough L. V. and Cleaver Bank; after January 1st from Cape Gris-Nez and Calais, as the fresh-herring fishery was continued for an unusually long period into the new year.

The selective action of drift-nets is, as a matter of fact, an important factor in the homogeneity of our samples. Of late our drift-net fishery has been carried out, however, by more or less standardized nets (made of cotton twine, long 600—620 meshes, deep 340 meshes, 33—35 meshes to the yard, in new and tanned condition. 10 % of length is allowed for shrinking). As such nets have been in general use of late years throughout the fleet, length-assessments may be comparable.

One sample was caught by trawl, near Calais and consisted largely of young herrings. As the method of capture was different, we have not included it in our considerations on age distribution.

I. The average length of our whole material (3466 ind.) was 24.98 cm., as against 25.43 cm. in the winter of 1934—35, so that here already is an indication of young year-groups making their appearance during last winter.

Average length (in ‰) of Herring in Winters 1934—35, and 1935—36.

| cm. | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1934—35 | — | 2 | 25 | 70 | 144 | 273 | 257 | 154 | 59 | 14 | 2 |
| 1935—36 | 3 | 16 | 65 | 136 | 192 | 174 | 175 | 168 | 59 | 10 | 2 |

We see that, while the winter of 1934—35 was largely characterised by an abundance of middle-sized fishes, last winter's fishing yielded an abundance of small herrings, but also fishes of 25—27 cm. were rather numerous.

The adjoining graph (Fig. 1) will illustrate this difference. The (dotted) curve for 1934—35 has only one maximum at 25, rising and falling steeply, but the straight curve of last winter shows a flattened top at 24 and a long hump, at only a slightly lower level, between 25 and 27.

The invasion of the population by large numbers of young herrings was already predicted by our colleagues J. Le Gall and G. Gilson, who both drew attention to the rich recruitment of the shoals by the new 1931 year-class during the winter 1934—35[1]).

At that time, however, our samples did not reveal this fact but were entirely dominated by the year-class 1929. It was only in our last series of samples that we found, both by measurement and by age assessment, the presence of two year-classes (threes and fours), and this altered the shape of our length curve considerably.

II. As to the age-distribution[2]) we may state that the results we obtained were wholly in accordance with the facts derived from the curve of lengths during the past winter.

During the winter 1934—35 we ascertained the following percentages for the different year-classes:

| Year-Class... | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 and + |
|---|---|---|---|---|---|---|---|---|
| Year of Birth | 1931 | 1930 | 1929 | 1928 | 1927 | 1926 | 1925 | 1924 and — |
| %..... | 7.6 | 15.6 | 47.6 | 14.4 | 9.5 | 2.8 | 0.9 | 0.9 |

[1]) Rapports et Proc.-Verb., Vol. XCIV, 1934—35, 2me Partie, p. 33, 3me Partie, p. 76.

[2]) Not counting one sample of trawl-caught herrings (nearly all of 3 or 4 years of age) at the end of January 1936 near Calais.

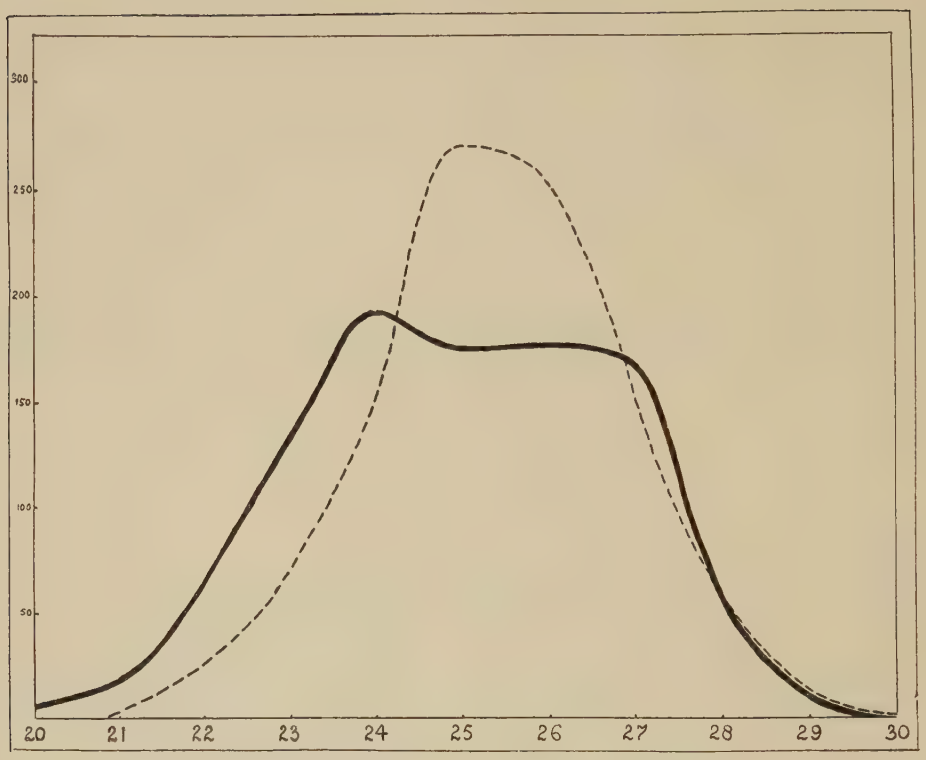



Fig. 1. Length of Herrings. Dotted curve: 1934—35; straight curve: 1935—36.

As has been stated above, however, the year-group 1931, then appearing as "recruits", did not reveal its real abundance to us, though found by other investigators. This prolific brood showed itself particularly abundant in autumn and winter 1935—36 (October to February incl.) and amounted to about a third of the total of herrings in our samples. Besides, there appeared a new class, that of 1932, in large quantities, which also promises to add to the abundance of the younger year-classes during the next season.

This winter the actual percentages of the year-classes in our material (together 3238 ind.) were as follows:

| Year-Class ... | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 and + |
|---|---|---|---|---|---|---|---|---|
| Year of Birth. | 1932 | 1931 | 1930 | 1929 | 1928 | 1927 | 1926 | 1925 and — |
| 1.X.-15.XII.35 | *18.6* | *30.6* | 12.9 | *21.9* | 8.6 | 5.0 | 1.6 | 0.4[1] |
| 1.I.-29.II.36 .. | *16.2* | *33.2* | 9.7 | *28.9* | 7.4 | 2.8 | 1.0 | 0.2 |

For comparison the following percentages, found by J. Le Gall[2]), are added:

| Year-Class... | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | + |
|---|---|---|---|---|---|---|---|---|---|
| % ..... | *24.6* | *28.1* | 5.1 | *29.*2 | 6.1 | 4.3 | 1.6 | 0.7 | 0.3 |

We see, then, that our age-assessments are fairly in accordance with Le Gall's. In all three series the threes, fours and sixes are predominant. The strength of the six-year-olds, of the brood-year 1929, was of course to be expected (though we assumed it to be higher in our forecast of this season[3]), as all investigators concerned pointed out their outstanding characteristic abundance in the previous season. Also the 4-year-olds had been designated by other workers than we as a conspicuous feature to be expected. But on top of this rich year-class comes another, that of 1932, that promises to be even more important than the preceding one[4]). On the other hand the failure of the 1930-brood, now 5 years of age, is particularly striking.

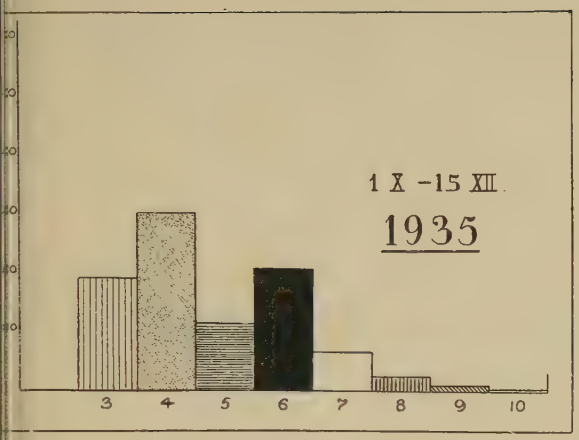
The preponderance of the threes and fours in the diagrams of Fig. 2 tends to lower the importance of the 1929 year-class, which we had emphasised in our attempted forecast for 1935. The percentage of that particular year-group had been estimated at 34, that of 1931 at 22 for the season 1935—36, whereas in point of fact these percentages were

[1]) The remaining percentages of scales belonged to a few fishes of unascertainable age.

[2]) In Draft Rep. Southern North Sea Committee for 1935, p. 51.

[3]) Rapp. et Proc.-Verb., Vol. XCIV, 3me Partie p. 74.

[4]) Hodgson, in his report of the last East-Anglia fishing, mentions as most abundant the threes, sixes and eights, but says nothing about fours.




ig. 2 A. Age-distribution of Year-classes of Herrings; Oct. to Dec. 1935.

Fig. 2 B. Age-distribution of Year-classes of Herrings, Jan. to Febr. 1936.

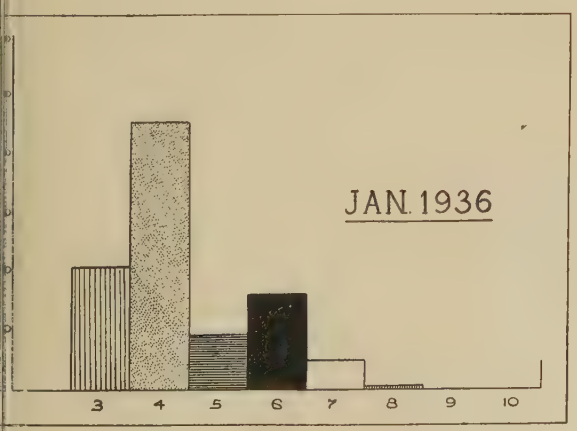
most exactly the reverse. This is due 1) to our nderestimating the strength of the 1931 year-class nd 2) to the rich crop of "recruits" (of 1932) appearing the population, both circumstances tending to wer the relative strength of the 6-year-olds.

That the early appearance of the younger year-asses (3 and 4) in the October shoals has again een confirmed in this last East-Anglia fishery is a act, so repeatedly stated by previous investigations, hat we may pass it over without much comment.

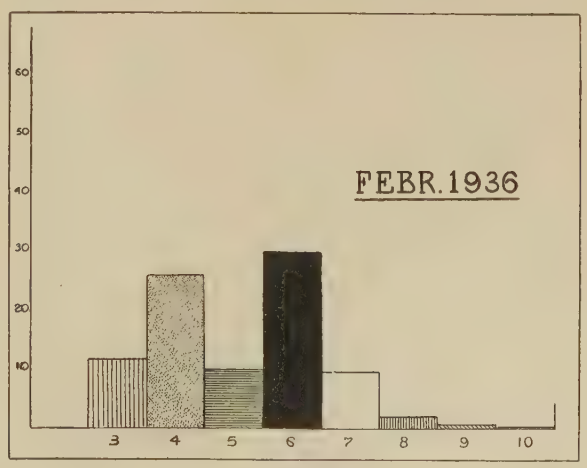
Another feature, however, deserves attention. In rmer years we had no opportunity to extend our ale readings well into the new year (only January 935 was included in our former consideration on he season 1934—35), but, owing to the fact that st winter the fishing of fresh herrings by drift-nets as extended unusually far into far into the new ar, we are able to furnish some information on he fishing in January and February 1936.

In doing this we encroach somewhat upon the activities of GILSON who devoted his attention for a number of years continuously to the spent herring population off the Belgian coast during winter, and who wrote an interesting treatise on this fishery of 1930—31[1]). In following this fishing and its yields carefully the author shows and explains at full length that in the course of time (from the end of December till the beginning of March) the earlier stages of this fishing is characterised by an abundance of older herrings, but that at the end of January the younger fishes invade the population of spents or recovering herrings. (See his diagram 12 and p. 30—31, also diagram 21, p. 46). Of course this also entails at the same time a sudden falling off of the average length.

[1]) Recherches s. l. Biologie du Hareng "guai" etc. Ann. de l'Institut d'études maritimes d'Ostende, mem. no. 1.




A.




B.

Fig. 3. Age-distribution of Year-classes of Herrings: A. January. B. February 1936.

Now, if we examine our Fig. 3, in which the age-diagrams for January and February 1936 are given separately, we arrive at an exactly opposite conclusion: in our material of these months (1198 ind.) the threes and fours are much more numerous in January (nearly two-thirds of the total number) and fall off considerably in February, giving way to the older year-classes; so that the sixes number only 17 % in January and double this percentage in the next month.

The explanation of the difference between GILSON's findings and ours is in our opinion given by two important points. Firstly our material was drift-net-caught, while GILSON's herrings were taken by trawl (which of course takes more of the smaller fish). Secondly the regions where our material came from were the waters of Calais and Dieppe (in any case beyond Cape Gris-Nez), while GILSON examined fish between that latter cape and Ostend. Anyhow, the fact seems of some importance and needs attention.

The actual percentages of our January-February material (nearly 1200 ind., practically all newly spent) were the following:

| Year-Class.. | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 and + |
|---|---|---|---|---|---|---|---|---|
| Year of Birth | 1932 | 1931 | 1930 | 1929 | 1928 | 1927 | 1926 | 1925 and — |
| January .. | 21.7 | *45.8* | 9.5 | 17.0 | 4.5 | 1.0 | 0.2 | 0.0 [1]) |
| February . | 13.4 | 26.9 | 9.8 | *35.0* | 8.9 | 3.6 | 1.2 | 0.4 |

[1]) Remaining small percentage of scales of uncertain age.

That trawl-caught herrings, at least in this regio and at that time of year, may display an age-fre quency, vastly different from that of drift-ne catches, is corroborated by the following exampl (250 trawl herrings caught near Calais, 28.I.1936)

| Year-Class | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | ? |
|---|---|---|---|---|---|---|---|---|---|
| % | 45.6 | 36.8 | 4.8 | 5.6 | 4.0 | 0.4 | 0.4 | 0.4 | 2.0 |

III. We think it useful for further comparison t give here also the average length of the year classes as calculated from all our material collecte during the winters of 1934—35 and 1935—36.

Average length of year-classes in cm.

| | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 and + |
|---|---|---|---|---|---|---|---|---|
| 1934-35 | 23.13 | 24.41 | 25.40 | 26.26 | 26.76 | 27.30 | 27.77 | 28.14 |
| 1935-36 | 23.06 | 24.18 | 25.50 | 26.27 | 26.93 | 27.28 | 27.89 | 28.33 |

There is no need for much comment on these data, as they have often been verified — except, perhaps, for the statement, put forth by LISSNER on a former occasion, that in quite a general way we can guess at the probable age of each particular herring by taking the unity of the number (in cm.) that indicates its length above 20 cm. This is not, however, to be applied to herrings from 26.5 cm. upwards, and is not more than a mere provisional guess.

# 4.

## Handliste zur Sicherung der Bestimmungen nordischen Planktons.

Herausgegeben von
H. H. Gran, E. Hentschel und F. S. Russell.

### Vorbemerkungen.

Fast alle Untersuchungen über das Plankton beginnen mit einer Benennung der zur Beobachtung kommenden Organismen. Diese Benennung soll eine "Bestimmung" sein, d. h. sie soll angeben, welcher Familie, Gattung, Art u. s. w. der Organismus angehört. Als "durchbestimmt" gilt ein Material, wenn im allgemeinen alle Organismen bis zur Art bestimmt sind.

Die sichere Bestimmung aller Arten erfordert, schon wenn sie sich auf eine Teilgruppe beschränkt, beispielsweise etwa die Peridineen, umfangreiche Specialkenntnisse. Sie ist für die Gesamtheit eines Planktons, d.h. bezug auf alle darin vorkommenden Organismengruppen, praktisch unausführbar. Infolgedessen enthält die Planktonliteratur viele Arbeiten mit mehr oder weniger unzuverlässigen Benennungen der Organismen.

Die Durchbestimmung aller Arten ist also eine undurchführbare Forderung. Dagegen ist die Zuverlässigkeit der Benennung eine Forderung, die bei jeder wissenschaftlichen Untersuchung unbedingt gestellt werden muss. Es erscheint daher zweckmässig, von Fall zu Fall festzustellen, wie weit die Bestimmung noch von einem Nichtspecialisten sicher durchgeführt werden kann, und sie nicht weiter als bis zu dieser Grenze durchzuführen.

Hinzu kommt, dass bei Untersuchungen, bei denen die Organismen des Planktons, und zwar oft von vielreichen Fängen, berücksichtigt werden sollen, die Benennung mit einfachen Mitteln durchgeführt werden muss. Es ist in solchen Fällen, insbesondere bei Zählungen, nicht möglich, etwa Gliedmassen von Copepoden abzupräparieren, die Plattenanordnung an Peridineenpanzern genau festzustellen u. dgl. m. Die Benennung muss im allgemeinen "auf den ersten Blick" möglich sein. Die Bestimmung kann daher nur so weit durchgeführt werden, wie sie auf den ersten Blick durchführbar ist.

Eine dritte Einschränkung der Bestimmungen ist gerechtigt infolge der grösseren oder geringeren Wichtigkeit der Arten für die Untersuchung. In vielen Fällen werden Bestimmungen, die in einer Reihe von Zählungen durchgeführt worden sind, bei der Auswertung der Ergebnisse garnicht ausgenutzt. Es werden z. B. nur etwa die Hauptgattungen der Diatomeen oder gar nur die Diatomeen insgesamt besprochen, nicht aber ihre einzelnen Arten. Dann ist aber ein Teil, und zwar oft ein besonders schwieriger Teil der geleisteten Arbeit überflüssig gewesen. Selbstverständlich wird es für spätere Untersuchungen immer wertvoll sein, wenn viele Arten durchbestimmt sind, sofern die Bestimmungen zuverlässig sind.

Aus diesen Gründen scheint es empfehlenswert, bei Totaluntersuchungen von Planktonfängen weniger Mühe auf eine Durchbestimmung der Arten zu verwenden, dagegen mehr für die Zuverlässigkeit der Benennungen zu sorgen. Dadurch wird nicht nur eine grössere Sicherheit der Ergebnisse erzielt werden, sondern auch eine Verringerung der Arbeit. Die Planktonforschung ist ja oft durch den grossen Zeitverbrauch bei ihren Untersuchungen stark im Nachteil gegenüber der Hydrographie und verwandten Wissenschaften.

Dass neben den hier empfohlenen Bestrebungen genaue systematische (taxonomische) Untersuchungen einzelner Organismengruppen durch Specialisten vollkommen ihren Wert behalten, soll ausdrücklich betont werden. Es wäre nur falsch, von dem mit allgemeinen meeresbiologischen Problemen beschäftigten Planktonforscher dieselben Bestimmungsleistungen zu fordern wie von dem Erforscher einer Einzelgruppe. Beide müssen die gleiche Zuverlässigkeit ihrer Benennungen zu erreichen suchen, jedoch auf verschiedene Weise.

Um die aufgestellten Grundsätze verwirklichen zu können, wird es nötig sein, anzugeben

1) was bei Totaluntersuchungen von Planktonfängen wichtig und was nicht wichtig ist,

2) was in dem besprochenen Sinne bestimmbar und was nicht bestimmbar ist.

Bei dem Versuch, diese beiden Fragen zu beantworten, sollen folgende Einschränkungen vorgenommen werden. Es soll nur das Arbeitsgebiet der Internationalen Meeresforschung berücksichtigt werden unter Ausschaltung gewisser peripherer Teile (eigent-

liche Ostsee und Barentsmeer), sodass das Gebiet ein einigermassen einheitliches und nicht allzu formenreiches Plankton enthält. Ferner soll nur das Plankton berücksichtigt werden, welches mit gewöhnlichen Seidengazenetzen von geringer Maschenweite gefangen wird, da sich die meisten Planktonuntersuchungen auf solches (Micro- und Mesoplankton) beziehen.

Als wichtig werden bei dieser Beschränkung zunächst diejenigen Arten gelten müssen, welche in den betreffenden Meeren häufig sind. Ostenfeld hat (Résumé des Observations sur le Plankton, Bull. Planktonique, Cons. Int., 4me Partie, 1931, S. 667 ff.) auf eine allerdings etwas mechanische Weise festgestellt, was bei den internationalen Untersuchungen 1902—1908 sich als besonders häufig erwiesen hat. Eine Anzahl anderer Arten muss nach den Erfahrungen verschiedener Untersucher, wie sich aus der Literatur und persönlichen Mitteilungen ergibt, als gebietsweise wichtig gelten. Sie sind teilweise auch durch Häufigkeit, teilweise durch Regelmässigkeit des Vorkommens ausgezeichnet. Alle diese Arten sind in der folgenden Handliste zusammengestellt.

Arten, die selten sind, wurden nicht als wichtig in dem hier gemeinten Sinne betrachtet, weil sie im Gesamtbild eines Planktons immer ganz zurücktreten werden. Damit soll nicht gesagt sein, dass sie nicht für bestimmte Fragen, z. B. als Leitformen für die Beimengung geringer Mengen fremden Wassers örtlich und zeitlich beschränkt von Wichtigkeit sein können.

Die nach diesen Gesichtspunkten getroffene absichtlich beschränkte Auswahl von Arten wurde der Begutachtung durch eine Reihe erfahrener Planktonforscher an den zuständigen Instituten in Oslo, Kopenhagen Helgoland und Plymouth unterworfen, um ein Urte darüber zu gewinnen, welche Arten bis zur Ar bestimmbar und wie die übrigen zu benennen seien Es haben daran hauptsächlich mitgearbeitet T. Braarud, H. H. Gran, P. Jespersen, Cl. Künne M. Lebour, O. Paulsen, F. S. Russell un A. Wulff, während E. Hentschel (Hamburg) de Meinungsaustausch leitete. Die Tabelle enthält da Ergebnis der Umfragen. In den verhältnismässi wenigen Fällen, wo eine Einigkeit über die Bestimm barkeit nicht erzielt werden konnte, wurde eine Ar Abstimmung vorgenommen, sodass das Ergebnis i jedem Falle auf wenigstens 75 % der eingegangene Urteile gegründet ist. Einige wenige Fälle musste unentschieden bleiben. Wir sind den genannten Mit arbeitern zu grossem Dank dafür verpflichtet, dass si ihre wertvollen Erfahrungen zu unserer Verfügun gestellt haben.

Die Lösung der gestellten Aufgabe hat sich als rech schwierig erwiesen, da die Fragen wichtig ode unwichtig und bestimmbar oder nicht bestimmbar i vielen Fällen sich nicht mit einem einfachen Ja ode Nein beantworten lassen. Immerhin glauben wir, ein brauchbare Handliste zustande gebracht zu haben welche geeignet sein wird, die Zuverlässigkeit de Planktonbestimmungen im Bereich der Internatio nalen Meeresforschung zu erhöhen und die Unter suchungen zu vereinfachen. Wir nehmen an, dass sich diese Grundliste in der Zukunft wird verbessern und durch Listen über andere Grössenordnungen des Planktons oder andere Planktongebiete ergänzen lassen.

## Zum Verständnis der Liste.

Gebietsbezeichnungen im Anschluss an Ostenfeld (*l. c.*, Chart of the Plankton Areas). *C* Centralregion [Nördl. Nordsee], *SW* Südwestregion [Engl. Kanal, Bristol Kanal], *S* Südregion [Südliche Nordsee, Flämische See], *SO* Südostregion [Beltsee, Kattegat (Skagerak)], *N* Nordregion [Faeröer-Shetland-Gebiet, Faeröer-Island-Gebiet, Norwegisches Meer].

\+ bedeutet: wichtig für das Gebiet.

| Bestimmungsbezeichnungen. | Es bedeutet: |
|---|---|
| spec. | bis zur Art sicher bestimmbar. |
| gen., subgen., fam., subord., ord. | nur bis zur Gattung, Untergattung u. s. w. zu bestimmen. |
| gen. (spec.?) | Bestimmbarkeit der Art zweifelhaft. |
| gen. (= spec.) | Die Gattungsbestimmung kann als Artbestimmung gelten, da nur eine Art (im Gebiet) vorkommt. |
| spec. s. l. | Die Benennung beschränkt sich nicht streng auf die Art, daher die Angabe "*sensu latiori*" hinter dem Artnamen. |

| Art | SW. | S. | SE. | C. | N. | Bestimmung |
|---|---|---|---|---|---|---|
| **Schizophyceae** | | | | | | |
| abaena baltica | .. | .. | + | .. | .. | gen. |
| dularia spumigera | .. | .. | + | .. | .. | gen. (= spec.) |
| chodesmium | + | .. | .. | .. | .. | gen. |
| **Chlorophyceae** | | | | | | |
| losphaera viridis | + | .. | .. | + | + | gen. (= spec.) |
| **Diatomaceae** | | | | | | |
| tinoptychus undulatus | + | + | .. | .. | .. | gen. |
| terionella bleakleyi | .. | + | .. | .. | .. | spec. |
| — japonica | + | + | .. | .. | + | spec. |
| teromphalus | .. | .. | .. | .. | + | gen. |
| cillaria paradoxa | + | + | .. | .. | .. | spec. |
| llerochea malleus | + | .. | .. | .. | .. | gen. (= spec.) |
| ldulphia aurita | .. | .. | + | .. | + | spec. |
| — granulata | .. | + | .. | .. | .. | spec. |
| — mobiliensis | + | + | .. | .. | .. | spec. |
| — regia | + | + | .. | .. | .. | spec. |
| — rhombus | .. | + | .. | .. | .. | spec. |
| — sinensis | + | + | + | .. | .. | spec. |
| ataulina bergoni | + | + | + | + | + | gen. (= spec.) |
| aetoceros affinis | + | .. | .. | .. | .. | gen. (spec.?) |
| — atlanticus | .. | .. | .. | + | + | spec. |
| — borealis | + | + | + | + | + | subgen. |
| — brevis | .. | + | .. | .. | .. | gen. |
| — cinctus | .. | .. | .. | .. | + | gen. |
| — compressus | .. | .. | + | .. | .. | gen. |
| — constrictus | .. | .. | + | .. | + | spec. |
| — curvisetus | + | .. | + | .. | .. | gen. (spec.?) |
| — danicus | + | .. | + | .. | .. | gen. |
| — debilis | .. | .. | .. | + | + | gen. (spec.?) |
| — decipiens | + | .. | + | + | + | spec. |
| — densus | + | + | .. | .. | + | subgen. |
| — diadema | .. | .. | .. | .. | + | gen. |
| — didymus | + | .. | + | .. | .. | gen. (spec.?) |
| — furca | + | .. | .. | .. | .. | spec. |
| — furcellatus | .. | .. | .. | .. | + | gen. |
| — holsaticus | + | .. | .. | .. | .. | gen. |
| — radicans | .. | .. | .. | + | + | spec. |
| — socialis | + | + | + | .. | + | spec. s. l. |
| — cetera | .. | .. | .. | .. | .. | gen. |
| ethron criophilum | + | .. | .. | .. | .. | gen. (= spec.) |
| cinodiscus centralis | .. | .. | .. | + | + | gen. |

| Art | SW. | S. | SE. | C. | N. | Bestimmung |
|---|---|---|---|---|---|---|
| Coscinodiscus concinnus | + | + | .. | + | .. | gen. |
| — excentricus | + | + | .. | + | .. | gen. |
| — grani | + | .. | .. | .. | .. | gen. |
| — radiatus | + | .. | .. | + | + | gen. |
| Dactyliosolen antarcticus | .. | .. | .. | .. | + | spec. |
| Ditylium brightwelli | + | + | .. | .. | .. | gen. (= spec.) |
| Eucampia zodiacus | + | + | .. | .. | .. | gen. (= spec.) |
| Guinardia flaccida | + | + | (+) | + | .. | gen. (= spec.) |
| Hyalodiscus stelliger | + | .. | .. | .. | .. | gen. (= spec.) |
| Lauderia borealis | + | + | .. | + | .. | gen. |
| Leptocylindrus danicus | + | .. | + | + | .. | gen. |
| — minimus | .. | + | .. | .. | .. | gen. |
| Nitzschia delicatissima | + | + | .. | .. | .. | vide N. seriata |
| — seriata | + | .. | .. | + | + | spec. s. l. (+ delicatissima) |
| Paralia sulcata | + | .. | .. | .. | .. | spec. |
| Porosira glacialis | .. | .. | + | .. | .. | gen. (= spec.) |
| Rhizosolenia alata | + | .. | .. | + | + | spec. |
| — delicatula | .. | + | .. | .. | .. | gen. |
| — gracillima | .. | .. | + | .. | .. | gen. |
| — robusta | + | .. | .. | .. | .. | gen. (spec.?) |
| — semispina | + | .. | .. | .. | + | spec. |
| — setigera | + | .. | .. | .. | .. | gen. (spec.?) |
| — shrubsolei | + | + | .. | + | + | spec. s. l. (+ styliformis) |
| — stolterfothii | + | + | .. | .. | .. | spec. |
| — styliformis | + | + | .. | + | + | spec. s. l. (+ shrubsolei) |
| Skeletonema costatum | + | .. | (+) | .. | + | spec. |
| Stephanopyxis turris | .. | + | .. | .. | .. | gen. |
| Streptotheca thamensis | + | + | .. | .. | .. | gen. (= spec.) |
| Thalassiosira gravida | + | .. | .. | .. | + | gen. |
| — hyalina | .. | .. | .. | .. | + | gen. |
| — nordenskiöldii | + | .. | .. | + | + | spec. |
| Thalassiothrix frauenfeldii | .. | .. | .. | .. | + | spec. s. l. (+ nitzschioides) |
| — longissima | .. | .. | .. | .. | + | spec. |
| — nitzschioides | + | + | + | .. | + | spec. s. l. (+ frauenfeldii) |
| **Peridiniales** | | | | | | |
| Ceratium arcticum | .. | .. | .. | .. | + | spec. |
| — azoricum | + | .. | .. | .. | .. | spec. |
| — bucephalum | + | .. | .. | .. | .. | gen. (spec.?) |
| — furca | + | + | (+) | + | + | spec. |
| — fusus | + | + | + | + | + | spec. |
| — horridum | .. | .. | .. | + | + | spec. |
| — lineatum | .. | .. | + | .. | .. | spec. |
| — longipes | + | + | + | + | + | spec. |
| — macroceros | + | + | + | + | .. | spec. |
| — tripos | + | + | + | + | + | spec. |
| Dinophysis acuta | + | .. | .. | + | .. | gen. |
| — norvegica | .. | .. | .. | .. | + | gen. |
| Diplopsalis lenticula | + | .. | .. | + | + | vide Peridinium |
| Noctiluca miliaris | + | + | .. | .. | .. | gen. (= spec.) |
| Peridinium depressum | + | .. | .. | + | + | spec. |
| — divergens | .. | .. | .. | + | .. | gen. |
| — islandicum | .. | .. | .. | .. | + | gen. |
| — ovatum | + | + | (+) | + | + | spec. |
| — pallidum | + | .. | .. | + | + | gen. |
| — pellucidum | + | + | .. | + | + | spec. |
| — cetera | .. | .. | .. | .. | .. | gen. (incl. Diplopsalis) |
| **Flagellata** | | | | | | |
| Dinobryon pellucidum | .. | .. | + | .. | .. | gen. |

| Art | SW. | S. | SE. | C. | N. | Bestimmung |
|---|---|---|---|---|---|---|
| ıaeocystis globosa | + | + | .. | .. | .. | gen. |
| — pouchetii | .. | .. | .. | + | .. | gen. |
| **Protozoa** | | | | | | |
| canthometron | .. | .. | .. | + | .. | gen. |
| llozoum inerme | .. | .. | .. | .. | + | gen. |
| obigerina bulloides | + | .. | .. | .. | .. | gen. |
| boea | + | + | + | + | .. | gen. |
| rafavella denticulata | .. | .. | .. | + | + | gen. |
| — gigantea | .. | .. | .. | + | .. | gen. |
| otocystis tridens | .. | .. | .. | + | .. | spec. |
| ychocylis urnula | .. | + | .. | .. | + | gen. (spec.?) |
| ntinnopsis beroidea | + | .. | .. | .. | .. | gen. |
| — campanula | + | + | .. | .. | .. | gen. |
| — ventricosa | + | + | .. | .. | .. | gen. |
| **Coelenterata** | | | | | | |
| lantha digitalis | + | .. | (+) | .. | + | gen. |
| thomedusae | .. | .. | .. | .. | .. | ord. |
| roë | + | .. | .. | .. | + | gen. |
| ptomedusae | .. | .. | .. | .. | .. | ord. |
| ıggiaea atlantica | + | .. | .. | .. | .. | gen. (spec.?) |
| — kochi | + | .. | .. | .. | .. | gen. (spec.?) |
| elia | + | .. | + | .. | .. | gen. |
| urobrachia pileus | .. | + | + | .. | .. | gen. |
| **Vermes** | | | | | | |
| mopteris helgolandica | + | .. | .. | .. | .. | gen. |
| **Copepoda** | | | | | | |
| artia bifilosa | .. | .. | + | .. | .. | gen. (spec.?) |
| — clausi | + | + | + | + | .. | gen. (spec.?) |
| — longiremis | .. | .. | + | .. | .. | gen. (spec.?) |
| tideus armatus | .. | .. | .. | .. | + | spec. |
| omalocera pattersoni | + | .. | (+) | + | .. | spec. |
| lanus finmarchicus | + | + | + | + | + | spec. |
| — hyperboreus | .. | .. | .. | .. | + | spec. |
| ntropages hamatus | + | + | + | .. | .. | spec. |
| — typicus | + | .. | (+) | + | .. | spec. |
| rycaeus anglicus | + | .. | .. | .. | .. | gen. |
| chaeta glacialis | .. | .. | .. | .. | + | spec. |
| — hebes | + | .. | .. | .. | .. | spec. |
| — norvegica | .. | .. | (+) | + | .. | spec. |
| tterpe acutifrons | + | + | .. | .. | .. | gen. |
| tterorhabdus norvegicus | .. | .. | + | .. | .. | gen. |
| ttridia longa | .. | .. | (+) | .. | .. | spec. |
| — lucens | + | .. | .. | + | + | spec. |
| rocalanus pusillus | .. | .. | .. | .. | + | gen. |
| rosetella norvegica | .. | .. | .. | + | + | gen. |
| hona nana | + | + | .. | .. | .. | gen. |
| — plumifera | .. | .. | + | .. | .. | spec. |
| — similis | + | + | + | .. | + | gen. |
| caea conifera | .. | .. | .. | .. | + | gen. |
| racalanus parvus | + | + | + | .. | .. | vide Pseudocalanus |
| rapontella brevicornis | + | .. | .. | .. | .. | spec. |
| uromamma robusta | + | .. | .. | .. | .. | gen. |
| udocalanus elongatus | + | + | + | + | + | spec. s. l. (incl. Paracalanus) |
| mora longicornis | + | + | + | + | .. | spec. |

| Art | SW. | S. | SE. | C. | N. | Bestimmung |
|---|---|---|---|---|---|---|
| **Crustacea cetera** | | | | | | |
| Conchoecia elegans | .. | + | (+) | .. | .. | gen. |
| Evadne | + | .. | + | + | .. | gen. |
| Gastrosaccus | .. | + | .. | .. | .. | gen. (fam.) |
| Hyperidae | + | .. | .. | + | + | fam. |
| Meganyctiphanes norvegica | + | + | + | + | + | spec. |
| Mysidacea cetera | .. | .. | .. | .. | .. | subord. |
| Nyctiphanes couchi | + | .. | .. | + | + | spec. |
| Philomedes lilljeborgii | .. | .. | .. | .. | + | gen. |
| Podon | + | .. | + | + | .. | gen. |
| Thysanoessa inermis | + | .. | .. | + | + | gen. |
| **Mollusca** | | | | | | |
| Clione | + | .. | .. | .. | + | gen. |
| Limacina helicina | .. | .. | .. | .. | + | gen. |
| — retroversa | + | .. | (+) | .. | + | gen. |
| **Chaetognatha** | | | | | | |
| Krohnia hamata | .. | .. | (+) | .. | .. | gen. |
| Sagitta elegans | + | + | .. | .. | + | spec. |
| — serratodentata | + | .. | .. | .. | + | spec. |
| — setosa | + | + | .. | .. | .. | spec. |
| **Tunicata** | | | | | | |
| Doliolidae | + | .. | .. | .. | + | fam. |
| Fritillaria | + | .. | .. | .. | + | gen. |
| Oicopleura dioica | + | + | + | .. | .. | gen. |
| Salpidae | + | .. | .. | .. | + | fam. |

# 5.

## Summary of Paper on "The Distribution, Breeding and Feeding of some Important Plankton Organisms of the S.W. North Sea in 1934".[1])

By

R. S. Wimpenny, Lowestoft.

. *Calanus finmarchicus*, *Sagitta setosa* and *S. elegans*, efly from Hensen net catches made each month in 34, at six stations between Flamborough Head and S.W. Patch of the Dogger Bank, and from cruises de in June and October of the same year, but ering a wider area off the east coast of England, e been investigated with regard to their distri- ion, breeding, size and feeding.

. *Calanus finmarchicus* and *Sagitta elegans* resemble h other in appearing to depend upon the influence oceanic water flowing in from the north of the area cussed. *S. setosa* on the other hand is characteristic the mixed North Sea or "Bank" water.

. In all species the time and place of diatom growth an important effect. The monthly data suggest t the diatom growth beginning in May and culmi- ing in July was responsible for successful brood vivals in all species. The egg-patches of *Calanus narchicus* and *Sagitta setosa* revealed by the cruises June and October were generally coincident with near diatom patches, a form of distribution in ch they differed from that of the species as a ole. For the October cruise it was noticed that e mature and spawning *S. setosa* were found in the tom-rich south. It was also found that spent and wning individuals of this species were confined to -net hauls made within and not immediately side a patch of *Biddulphia sinensis* met with on October cruise. It is thought, as a result of this k and of that already published by Savage and MPENNY, that diatom patches in the area discussed as breeding and nursery grounds.

. The species dealt with appeared to have the owing breeding periods:—

| *Calanus finmarchicus* | *Sagitta setosa* | *Sagitta elegans* |
|---|---|---|
| January | April | January—February (?) |
| April—May | July | April—August |
| August | | October |

The *Calanus* observations are in agreement with other work in temperate regions, but the breeding periods of both species of *Sagitta* show evidence of being less numerous than those found at Plymouth by Russell.

5. For all species the broods born at the coldest time of the year appear to have produced the largest individuals. All species measured in the Flamborough area tended to be smaller than those measured by Russell, and on the October cruise over a wide area *Sagitta setosa* was smaller in the shallow south. This difference is thought to be connected with depth.

6. The organisms studied were found transparent enough to determine the proportion containing food. In *Calanus* it was found that this value fell with age up to stage V. Thereafter the proportion for females was higher, but for males lower. The monthly survey showed that the proportion of feeding *Calanus* rose to a maximum in the spring, but decreased at the time of diatom abundance and did not again recover its earlier values. The stage V individuals had a higher proportion containing food in the earlier part of the year. In the females the reverse was the case. The maximum proportion for *S. setosa* and *S. elegans* during the monthly observations were in May and June—July respectively. The cruise over a wider area in October revealed the maximum proportion with food for all species to lie in the diatom-rich south.

[1]) To be published in the "Fisheries Investigations of the Ministry of Agriculture and Fisheries", London.

# 6.

## Further Observations on Spent Herring with Remarks on Fluctuations and Oscillation.

By

G. Gilson, Ostend.

Systematic observations on the community of spent herring which accumulates every year along the French-Belgian coast have been carried on uninterruptedly during the fishing seasons of the last six years. This community of nearly pure spent herrings that returns regularly to our coast after the autumn spawning to remain for more than two months in a close vicinity to the shore, although very small in comparison with the immense shoals of the North Sea, offers excellent opportunities for general biological studies on the species. We beg to remind the readers of our previous papers, that our method consists in the analysis of a great number of small samples. Each sample of 25 fishes is obtained from the fishermen on each of the fishing days of the herring season. Each herring was submitted to the eight points of analysis which are now considered classical:

1) length
2) weight
3) sex
4) stage of gonads
5) quantity of mesenteric fat
6) age and growth from scales
7) number of vertebrae
8) content of stomach

It is intended to proceed with the same work for several years to come and to add yearly one step to the biological scale of the shoal. As seen in the diagram, the material collected in the season 1936 has been worked out already and a new step added to the scale.

A general Report on the results of the successive years will be published this year, may-be next year if the addition of the results of another year is found expedient.

For the present I shall simply call attention to certain peculiarities of the evolution of the year-classes that do not appear clearly enough in a columnar biological scale. In diagram no. 2, I have drawn a representation of the variation of percentages in a different way: each year-class is taken separately from its first appearance as fishery material and its evolution is followed to its extinction or near to it.

1. On the first coordinate, — on the left, — are plotted the percentages of each of the year groups of the six seasons that have been as yet under observation, at the time of their first appearance, — that is at the age of 3 years. They occupy various positions on the line and their variation during this period of years, may be called a fluctuation.

2. If we take the same year-groups on their second appearance, — that is in their 4th year of age, we make a similar remark: the figures of all percentages still occupy different levels. But there is a more interesting feature to be noted: that is, that they are all higher than in the preceding year. There is thus a constant increase in the number of herrings on their second migration to our coast. No exception to that rule has been observed, up to the present.

3. The right hand part of the graph shows a remarkable uniformity in the direction of the lines of percentages: they all, invariably after the 4th year of age, take a sloping direction indicating a gradual decrease in the number of herrings of each of the successive generations that have come to our coast after spawning, since the starting of our regular system of observation.

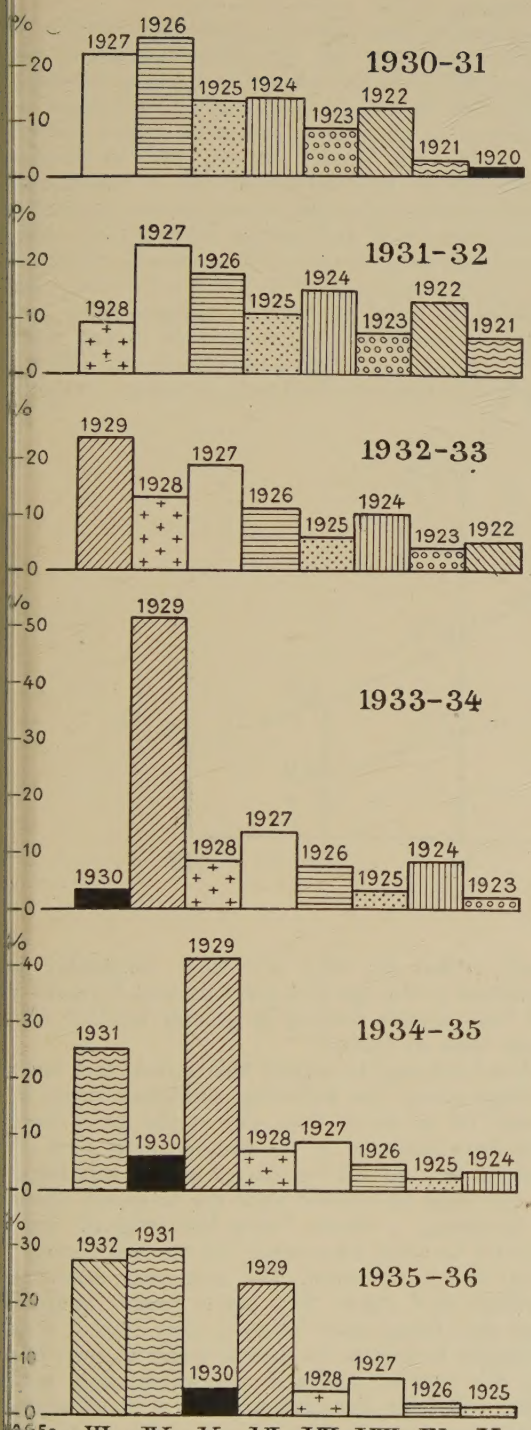
**Forecast for the season 1936—37.**— Good shoals may be expected for the following reasons:

a) the 1931-class which has played an important part in the rich seasons 1934—1935 and 1935—1936, will in 1936—1937 be at the first stage of reduction only;

b) a good remnant of the famous 1929-class is likely to survive;

c) the youngest class, 1932, attaining in 1936 the highest percentage hitherto recorded at the first appearance, will be reaching in 1936—1937, the augmentative stage of 4 years.

Our diagram no. 2, exposing the fluctuation and evolution of successive year-groups continuously recorded, may be useful for the drawing of forecasts concerning our shoal of littoral spents. Possibly also it could be adapted to the prevision of the future




Balancing of percentages : number of individuals of each year class in 100 fishes.

1. Percentage number of individuals in each year-class.

1930—31

| | |
|---|---|
| Number of herrings examined..... | 1,167 |
| Mean weight of a day's capture..... | 8,338 kg |
| Total weight landed in the season.... | 18,360,596 kg |
| Mean value of 100 kg..... | 71 fr. |
| Total value of the season ..... | 13,008,930 fr. |
| Number of individuals destroyed..... | 217,002,545 |

1931—32

| | |
|---|---|
| Number of herrings examined..... | 783 |
| Mean weight of a day's capture..... | 5,225 kg |
| Total weight landed in the season.... | 3,383,750 kg |
| Mean value of 100 kg..... | 108 fr. |
| Total value of the season..... | 3,642,806 fr. |
| Number of individuals destroyed..... | 34,992,241 |

1932—33

| | |
|---|---|
| Number of herrings examined..... | 1,000 |
| Mean weight of a day's capture..... | 4,514 kg |
| Total weight landed in the season.... | 2,673,185 kg |
| Mean value of 100 kg..... | 91.50 fr. |
| Total value of the season ..... | 2,446,867 fr. |
| Number of individuals destroyed..... | 29,405,035 |

1933—34

| | |
|---|---|
| Number of herrings examined..... | 1,479 |
| Mean weight of a day's capture..... | 7,600 kg |
| Total weight landed in the season.... | 7,455,800 kg |
| Mean value of 100 kg..... | 75 fr. |
| Total value of the season ..... | 5,577,441 fr. |
| Number of individuals destroyed..... | 76,861,050 |

1934—35

| | |
|---|---|
| Number of herrings examined..... | 1,200 |
| Mean weight of a day's capture..... | 14,632 kg |
| Total weight landed in the season.... | 12,322,990 kg |
| Mean value of 100 kg..... | 31.52 fr. |
| Total value of the season ..... | 3,856,044 fr. |
| Number of individuals destroyed..... | 123,553,199 |

1935—36

| | |
|---|---|
| Number of herrings examined..... | 1,300 |
| Mean weight of a day's capture..... | 11,120 kg |
| Total weight landed in the season.... | 8,595,895 kg |
| Mean value of 100 kg..... | 62 fr. |
| Total value of the season..... | 5,328,754 fr. |
| Number of individuals destroyed..... | 81,965,880 |

Number of herrings examined in 6 years: 6,929

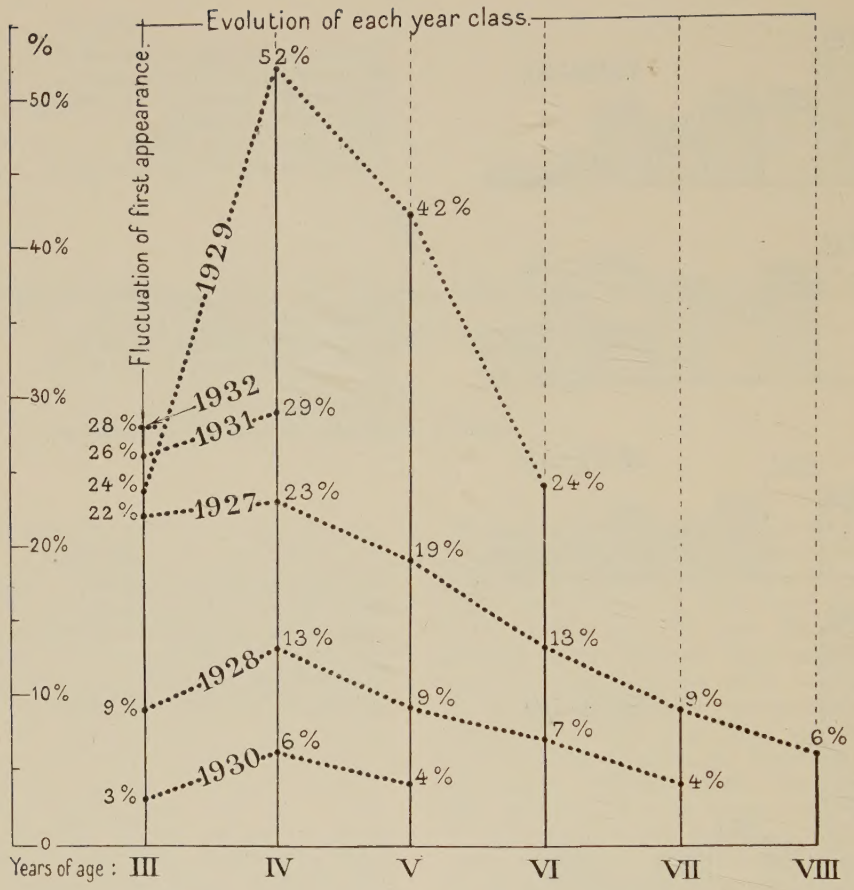



Fig. 2.

composition of certain larger communities of other kinds of herrings in the North Sea.

To these data I beg to add a few remarks concerning the probable cause of the fluctuation of the successive generations and of the strangely constant character of the evolution of each of them.

1°. The causes of *fluctuations* may be of various orders:

a) a group may have been poor from its origin, as a consequence of a deficient production of eggs in the ovaries or of unfavourable external conditions at the time of hatching and first development of the larvae;

b) external conditions prevailing after the spawning of the spent herrings may have been such as to directly favour, or, conversely, to oppose the coming of the spawners to our region in great number. External circumstances may thus have been partly the regulating factor of the abundance or scarcity of spent herrings in the resting place of our coast.

2°. The cause of the strangely *regular oscillation* in the number of spents, reaching our coast in successive years, appears much more difficult to determine. Why do the spawners of any generation appear in larger number, as spents, on their second coming to our coast, — that is: why are they constantly more abundant at the age of 4 years than at 3 years? Why are they always coming in greater number at four years than at three?

As an attempt to explain this curious fact one may perhaps accept the following, somewhat risky, hypothesis: let us admit that, out of the lot of herrings that have spawned in the southernmost part of the Flemish Sea, not all but only a certain number come to our coast to recover after the fatiguing operation of spawning, — others, being less fatigued, are able actively to swim away with the residual current and never touch our coast. The next year, however, as herrings of 4 years, they lay a greater quantity of eggs and, being more fatigued, they have a stronger tendency to remain in coastal water to rest. But, in the 5th year of age, and afterwards, they seem to suffer less from the spawning and a smaller number of them require a period of rest in the close vicinity of the coast, — the stronger ones leaving continuously the spawning grounds and swimming away to other regions. Meanwhile, the causes of mortality are in action and the number of herrings of each generation is gradually reduced to complete extinction.

I submit these facts, remarks and deductions to ose of our colleagues who pay special attention to e general question of fluctuations and of their causes d mechanism. Personnally, I am of the opinion at the results of a few more years of continuous servations are needed before the causes and echanisms of the fluctuation and of the general olution of the successive generations composing our nual shoal of spent herrings can be determined with tisfactory precision. If confirmed by further records, ese remarks may lead to the conclusion that varia- ns, either angular or sinusoid, when presenting a rtain degree of constancy and regularity, are due causes inherent to the living organism, whilst the uses of irregular or unsettled variations of biological phenomena must be looked for preferably in the less regular play of external conditions of environment.

A corollary of this conclusion, if sound, would be that one of the most variable of external causes of mortality, the action of the fishery, — tremendous as it seems to be, — has not yet been able to affect the normal biological cycle of the herring, and, as yet, is by no means threatening to the fishing industry.

The above explanatory remarks I present as a mere working hypothesis for further investigations and tending simply to show how urgently the solution of certain biological questions is in need of positive data that can only be expected from a continuous survey of the physical and biological conditions in the intermediate region Channel-North Sea.